

XVIII.—*On the Anatomy of Eurybia Gaudichaudi, as bearing upon its Position amongst the Pteropoda.* By JOHN DENIS MACDONALD, Assistant-Surgeon of H.M.S. 'Herald,' employed on Surveying Service in the South-western Pacific, under the command of Captain H. M. DENHAM, R.N., F.R.S. Communicated by G. BUSK, F.R.S., F.L.S.

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ONE of the most constant products of the towing-net, in the S.W. Pacific, is the little Pteropod *Eurybia Gaudichaudi*. It is often captured in the daytime, which is seldom the case with other members of its class.

The enveloping mantle forms a sac of an oval figure and scarcely exceeding  $\frac{1}{6}$ th of an inch in length, with an anterior transverse subterminal slit on the ventral side, giving passage to the head with its tentacula, a rudimentary foot, and the swimming-fins. It is composed of large spheroidal cartilage-cells, in which the nuclei are distinctly visible, and a sparingly interspersed fibrous tissue, opposing an almost insuperable obstacle to the study of the internal anatomy of the animal.

The *Eurybia* may be said to possess a distinct head and neck, the head bearing on either side a large tapering and gently curved tentaculum, with a small nipple-like process at the inner side of the base. All these appendages are richly ciliated, the cilia being generally disposed in parallel, longitudinal lines, and exhibiting a dextral, undulatory motion.

The mouth is a vertical opening, with moderately prominent lateral lips, just within the borders of which may be noticed, according to the age of the animal, one, two, or three longitudinal series of small square plates, with a delicate cutting edge near the outer part of each.

The lingual ribbon is somewhat more lengthy than that of any other Pteropod with which I am acquainted. It presents a single row of simple, lancet-shaped teeth in the rachis, and a single row of fang-like uncini in each pleura. The buccal mass is globose in figure, and composed of fibro-cartilage with investing muscular fibres.

A very distinct though rather small foot springs from the under surface of the body, considerably behind the head, having a flat creeping-disc, with a subquadrate anterior and a pointed posterior extremity, and in many particulars closely resembling the foot of the true pelagic Gasteropods.

The swimming-fins are unquestionably the epipodia of this foot, arising by a subcylindrical base, just above the lateral border, and near the middle of its root. These organs at first diminish a little in size, and then gradually expand to form a broad and laterally compressed paddle, widely emarginated at its extremity.

The œsophagus holds a dorsal position, and is distinguished from the other parts of the alimentary canal by the thickness of its walls and its richly ciliated lining.

The stomach is large, consisting of several wide sacculated portions, the exterior of which



is beset with large hepatic lobuli containing cells distended with rich brown-red, yellow, and green fatty globules, imparting to them a beautifully variegated appearance. No gastric plates or teeth are visible, though universally present in the true Thecosomata. Having left the stomach, the intestine soon curves forwards to terminate anteriorly near the generative openings, on the right side of the body.

The salivary secretion is furnished by two irregularly lobulated organs, lined with rather large secreting cells, and lying one on either side of the œsophagus as it emerges from the buccal mass.

The heart occupies an antero-dorsal position, and its long axis appears to lie transversely; but I have not been able to detect a respiratory organ, or even the actual distribution of the blood-vessels.

The main centres of the nervous system are the subœsophageal ganglia, which are well developed, and support the auditory capsules containing vibrating otokonia on their inferior surface.

The ovarium consists of a fan-like expansion of lobuli, on the borders and extremities of which the ova are clustered within the enveloping sheath. From this expansion a number of tubuli arise, and ultimately unite to form a wide oviduct distinguished from the spermatic duct and intestine by the large longitudinal and nucleated fibres of its muscular coat. A large cæcal appendage, distended with a bright-orange and plastic fluid, appears to open by a short duct at the same external orifice. This organ is probably the homologue of the so-called spermatheca of the Pulmoniferous Gasteropods; and its contained fluid offers a remarkable analogy to that occurring in the ovarian sac of some Cephalopods.

The lobuli of the testis lie upon and coincide so closely with those of the ovarium, that it is difficult to distinguish them; but the stout vas deferens, arising from the point at which the divisions converge, soon communicates, above and a little to the right of the ovary, with a spheroidal sac or vesicula seminalis, which may be readily seen from without, through the cartilaginous mantle. The spermatic duct thence proceeds forwards in company with the oviduct, and enters the neck of the external male organ, to terminate in a perforated dart or rigid point, which occupies the fundus of the inner protrusible membrane of a double-walled pyriform sac having an external orifice near that of the oviduct, on the right side, behind the corresponding swimming-fin.

The spermatozoa of this Pteropod are remarkable for their great length and peculiar looping and spirally twisting movements, as illustrated in Pl. XLIII. fig. 8 B b. The filaments appear to rotate on their long axes, and twirl up, like an over-spun thread unlay themselves, and twist up again, with wonderful rapidity while their activity lasts.

*Eurybia* is ovo-viviparous; and the development of the young may be studied with much interest while yet within the body of the parent. The simple capsule of the ovum offers but little for remark; but the included embryo in the comparatively advanced stage exhibits many points of analogy to that of an ordinary Gasteropod.

The incipient cartilaginous mantle is of large size compared with the embryo itself. It is globose in figure, with an opening at one end, through which the ciliated vela of the young *Eurybia* may be seen protruding. These latter organs form expanded lobes, lying



one on either side of the head, having the borders beset with large vibratile cilia. A frontal elevation rises up between them, from which, it would appear, the future tentacula spring. At this period of development the rudimentary external parts exhibit a loose cellular structure, the basis of the more complex tissues of the full-grown animal.

The cephalic ganglia show themselves very distinctly, through the transparent envelopes, as disproportionately large and rounded masses; and the auditory sacs, containing a single primordial otolithe, lie quite in contact with their nervous centres.

The intestine may be seen taking a simple horse-shoe flexure towards the neural surface, while the gastric dilatation fills up the hollow of the curve to a considerable extent.

The organ above described as corresponding with the spermatheca of the Pulmoniferous Gasteropods is just visible on the right side; and what appears to be the true vesicula seminalis on the left.

The external surface of the mantle is pretty equally divided into three zones, by two ciliated rings disposed transversely, and consisting of a single series of prominent cells bearing moderately large cilia.

The development of the cartilage-cells of the mantle may be traced at any part, from the round transparent nucleus and its acquisition of a membranous investment, to their perfect condition as structural elements.

The fibrous tissue may be also seen in course of evolution, from very thin-walled cells formed upon plastic but minutely granular nuclei. Having attained a certain size, the cell-wall shoots forth into delicate tubular processes, which either spring from two opposite ends; or irregularly from several parts of the circumference. As the nutrition of the cells goes forward, the simple tubular processes increase in length and in bulk, more particularly at the base, and break up into numerous and exquisitely delicate ramusculi, by which the ultimate fibrillation of the body of the cell seems to be effected. The elongated or fusiform nuclei permanently remain to strengthen the tissue, which now begins to assume a reticulated structure in the intercellular spaces.

The remains of the ciliated rings of this embryo are distinguishable in *Eurybia* of considerable size; and from what has been above noticed of the anatomy of the animal and the intimate structure of the mantle (which, though answering the purpose of a shell, is, strictly speaking, not homologous with such), it is evident that this genus is not conformable to the characters of the Thecosomata or first section of the Pteropoda proposed by De Blainville.

The principal points of difference may be thus analysed:—

THECOSOMATA.	EURYBIA.
1. Animal furnished with an external shell.	1. No external shell.
2. Head indistinct.	2. Head and neck quite distinct.
3. Foot and tentacula rudimentary, combined with the fins.	3. The foot is small, and only on this account rudimentary; the tentacula are large, and not combined with the fins.
4. Mouth situated in a cavity formed by the union of the locomotive organs.	4. The mouth is not situated in a cavity formed by the locomotive organs.
5. Respiratory organs contained within the mantle-cavity.	5. This last particular may possibly apply.



In the following synopsis of the principal genera of Pteropoda, *Eurybia* occupies a position suggested by general anatomical principles, and which I believe to be the natural one\*.

## PTEROPODA.

<i>Gymnosomata.</i> Animal naked, head distinct. No gastric teeth apparent .....	{	Having a lingual pavement, dental cheek-pouches, and a membranous envelope .....	{	Central series of lingual pavement absent. Cheek-pouches deep and tentacular suckers large and well-developed ....	{	PNEUMODERMON.							
		Having a triserial lingual strap, numerous and minute lateral labial plates cutting longitudinally, and a cartilaginous mantle.....		Central series of lingual pavement present. Buccal pouches shallow, and tentacular suckers minute or rudimentary .....		CLIO.							
						EURYBIA.							
<i>Thecosomata.</i> Animal protected by a shell, with the head indistinct.  Having a triserial lingual ribbon, large and definite lateral labial plates cutting transversely, and two or more gastric teeth .....	{	Shell cartilaginous (symmetrical); gastric teeth 2 .....	{		{	CYMBULIA.							
		Shell calcareous; gastric teeth more than 2..		{		Shell symmetrical	{	With lateral slits through which processes of the mantle protrude .....	Commissures of the aperture closed..	HYALÆA.			
								Lateral borders entire	{	Parietes angular or compressed antero-posteriorly .....	Lateral slits communicating with the aperture....	DIACRIA.	
											Parietes round and smooth or crimped transversely .....		CLIODORA.
												Subcylindrical, apex decollated.	CUVIERIA.
													Acuminate, apex entire .....
		Shell sinistrally spiral.....		{		{	{	Inoperculate.....	LIMACINA.				
								Operculate .....	SPIRIALIS.				

It will be seen by the Table, that *Eurybia* differs still further from the true Thecosomata in the peculiar structure of its labial dental organs (whose cutting edges run longitudinally, not transversely), and in the total absence of gastric teeth.

The members of the last division, having calcareous shells, are too closely related by their internal anatomy to admit of their separation into two distinct families; and I am much inclined to believe, though not certain, that *Cymbulia* ought to be received amongst them. The families thus indicated are the *Clidæ*, *Eurybiidæ*, and *Hyalæidæ*, the principal amendment of the commonly received arrangement being the separation of *Eurybia* from the *Hyalæidæ*, with which it has been improperly associated; and the union of the *Limacina* with the same family, from which they have been unnecessarily dismembered. The species of *Spirialis* occurring in these seas may be truly described as the soft parts of *Creseis* occupying a spiral operculate shell aping that of the Gasteropod.

\* This table is advanced with a little more confidence as, it has benefited by the revising hand of Mr. W. S. MacLeay.



## EXPLANATION OF THE PLATE.

## TAB. XLIII.

- Fig. 1. *Eurybia Gaudichaudi*. Natural size.
- Fig. 2. *Eurybia Gaudichaudi*, magnified to show more distinctly its head, tentacula, oral aperture armed with lateral dental cells, the swimming-fins, and foot. The abdominal viscera are imperfectly seen through the transparent mantle.
- Fig. 3. Portion of the fibro-cartilaginous mantle, highly magnified.
- Fig. 4. The lateral labial teeth, forming in this case a double series.
- Fig. 5. Six of the dental cells belonging to the right side, still further magnified to show the longitudinal cutting edge near the external border of each.
- Fig. 6. Three transverse rows of the lingual ribbon. In this view the curvature of the lateral teeth is scarcely apparent.
- Fig. 7. The auditory capsule containing otokonial particles.
- Fig. 8. Generative systems: A *a.* expansion of the lobules of testis and ovarium lying in juxtaposition; A *b.* ova seen through the walls of the ovarian lobuli; A *c.* primary oviducts uniting in A *d.* the common duct; A *e.* vesicula seminalis; A *f.* the vas deferens; B *a.* pointed extremity of the penis, composed of indurated cells, and traversed by the ejaculatory canal; B *b.* spermatozoa exhibiting their peculiar looping and twisting movements.
- Fig. 9. Embryo of *Eurybia* within the ovum: *a.* frontal and lateral ciliated head-lobes; *b, b.* subœsophageal ganglia supporting the auditory sacs with their single primordial otolithes; *c.* alimentary canal with the rudimentary abdominal viscera; *d d, d d.* two ciliated rings which gird the exterior of the incipient cartilaginous mantle.
- Fig. 10. Structural elements of the mantle: *a.* portion of one of the ciliated rings of the embryo; *b.* stages of development of the fibrous tissue; *c.* cartilage-cells in different stages.



EURYBIA.

